

Comments on “First Results of the Phase II SIMPLE Dark Matter Search”

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The SIMPLE Collaboration has reported results from their superheated C_2ClF_5 droplet detectors [1, 2], including a description of acoustic discrimination between α decays and nuclear recoils. Our concern is that the events in the neutron calibration data and the events identified as neutrons in the physics data are not drawn from the same parent distribution. This fact calls into question the identification of the background events as neutrons, the use of the calibration data to define the acceptance of WIMP-induced nuclear recoils, and the observation of discrimination against α 's.

Figure 1 of [1] (reproduced in Fig. 1 below as a projection of the original figure onto its y-axis) shows four classes of data points representing three sets of data: α -spiked data, neutron calibration data, and the physics data.

The authors draw a line between the acoustic distributions observed in the calibration runs, defining events with amplitude below this line to be neutrons and those with amplitude above to be α 's.

The fundamental issue with the SIMPLE analysis is that the neutron calibration data set and the events identified as neutrons in the physics data do not have the same parent acoustic distribution, as shown in our Fig. 1. In the neutron calibration data, 89% of the events have $\ln((A/\text{mV})^2) < 7.5$, while none of the 14 identified neutrons from the physics data have $\ln((A/\text{mV})^2) < 7.5$. A two-sample K-S test gives a probability $< 10^{-10}$ that the datasets are samples of the same parent distribution. This raises two immediate questions: are the physics events identified as neutrons truly neutrons? If so, why is their acoustic distribution different from the calibration distribution?

The fact that the calibration and physics distributions do not agree directly affects the determined WIMP sensitivity. The neutron calibration source data is used to calculate an acceptance of 97% for the acoustic cut for nuclear recoils, setting the sensitivity of the physics modules to dark matter. As the data show that the acoustic distribution of the physics modules does not match the calibration, we believe that the actual acceptance of the acoustic cut when applied to the physics data is unknown.

We note that neutron sources were applied to neither the physics nor the α -spiked modules. Given the mismatch between the neutron calibrations and physics data, we wonder what neutrons would sound like in the

α -spiked modules. The authors' claim of discrimination relies on the assumption that the acoustic distributions in the α -spiked and neutron-calibration modules would agree.

If acoustic discrimination is indeed the source of the difference between the two calibration datasets, then α decays produce 400 times the acoustic power of nuclear recoils in the SIMPLE detectors. This is in tension with results from PICASSO and COUPP, using C_4F_{10} superheated droplet detectors and CF_3I bubble chambers, where α decays produce only 4 times the acoustic power of nuclear recoils [3, 4].

The SIMPLE Collaboration's interpretation of their data is not supported by the calibrations presented in the Letter. As a result, we must call into question the observation of acoustic discrimination and the reported dark matter sensitivity. We look forward to the resolution of these concerns as more information becomes available.

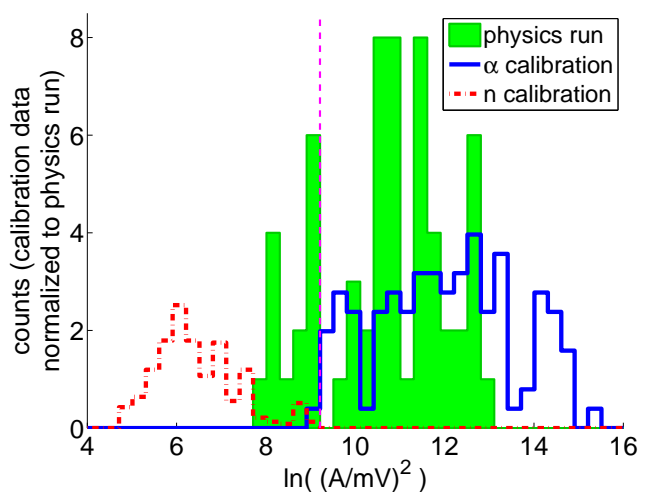


FIG. 1: Histogram of the data in Fig. 1 of [1] projected on its y-axis. The physics data to the left of the dashed line are identified as neutrons and those to the right as α 's. The y-axis is in counts for physics data, and each calibration histogram is scaled to have the same area as the corresponding region of the physics data. If the calibrations are representative, the physics data should match the sum of the calibration histograms.

[1] M. Felizardo *et al.*, Phys. Rev. Lett. **105**, 211301 (2010).

[2] M. Felizardo *et al.*, arXiv:1106.3014 (2011).

- [3] F. Aubin *et al.*, New Journal of Physics **10**, 103017 (2010).
- [4] E. Behnke *et al.*, Phys. Rev. Lett. **106**, 021303 (2011).